



DEPARTMENT OF THE AIR FORCE  
HEADQUARTERS USAF TACTICAL AIR WARFARE CENTER (TAC)  
EGLIN AIR FORCE BASE, FLORIDA 32542

27 OCT 1981

REPLY TO  
ATTN OF: CC

SUBJECT: Final Report, TAC Project 81A-114T, QOT&E of the F-16 20mm Ammunition Loading System's Ability to Upload/Download A-7D Aircraft

TO: HQ TAC/DR

1. INTRODUCTION.

a. Background. At present, the United States Air Force does not have a standardized 20mm ammunition loading system (ALS). Each tactical aircraft has a unique system for loading the ammunition drum while simultaneously downloading expended ammunition cases and unfired rounds. The loading systems for the F-4, F-15, and A-7 are similar in principle only. Each requires an ammunition trailer, a different loading head, and linked ammunition. This requirement for linked ammunition is a design anomaly in that these aircraft require linked ammunition for guns which have linkless internal feed systems. The F-16 is the only Air Force aircraft presently capable of accepting linkless ammunition. The F-16 ALS is the only linkless Air Force loading system. The F-16 ALS, with minor modifications to the M-61 gun systems, appears to fulfill all requirements for a universal ALS. To convert the F-4, F-15, and A-7 to accept a linkless loading system, the delinking feeder on the M-61 gun must be replaced by an aircraft unique adapter which accepts linkless ammunition. This adapter is used on United States Navy A-7Es to allow use of the Navy linkless ammunition loading system. Therefore, the A-7D, after being converted to accept linkless ammunition, would be suitable to test the ability of the F-16 ALS to load alternate aircraft. Authority for this test was provided under TACR 55-10, Tactical Air Command (TAC) Project Order 81A-114T, 4 August 1981, as amended by Headquarters (HQ) TAC/LGW letter dated 5 August 1981 and HQ TAC/LGW message R181901Z August 1981. Results of the test and evaluation are to be used to support recommendations for a universal 20mm ALS.

b. Description. The F-16 ALS consists of two major assemblies-- a 1,615 round flight line loader and an ammunition replenisher.

(1) The loader simultaneously uploads ammunition and downloads spent cases and unfired rounds from the aircraft gun system. The heart of the loader is a linkless storage drum using the same technology and many of the parts common to the F-16 gun system. The storage drum holds 1,473 rounds with the remaining 142 rounds stored in the conveyor assembly. The conveyor assembly passes ammunition to and from the aircraft and in and out of the loader. Both the storage drum and the

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conveyor assembly are supported by a four-wheeled chassis adapted from the standard MB-1 trailer. The loader operates using a self-contained pneumatic drive employing a standard 3,000 psi air bottle.

(2) The ammunition replenisher, used in the munitions storage area, simultaneously reloads bulk or linked ammunition into the loader and unloads and separates spent cases from the unfired ammunition during the downloading process. The replenisher contains fixed guides which automatically strip the cardboard protective dunnage from the ammunition projectiles as they are being loaded. Engineering Change Proposal (ECP) ALS-05606-0006R1 describes a multifunctioned automixing replenisher (hereafter referred to as the modified replenisher). Improvements included provisions for automatic ammunition mixing (TP, HEI, tracers), increased loading rates, recycling of downloaded ammunition, and improved ammunition handling.

c. Participating Agencies. The test was managed and conducted by the USAF Tactical Air Warfare Center (USAFTAWC). The point of contact is the project manager, 2Lt James W. Poe, USAFTAWC/LGMW, Autovon 872-4741. Aeronautical Systems Division (ASD) and General Electric were supporting organizations and provided the ALS for the test. The National Guard Bureau was also a supporting organization and provided the funds for the test. The 121st Tactical Fighter Wing (TFW) Air National Guard (ANG) provided the operational environment, munitions personnel, and A-7D aircraft for the test.

2. PURPOSE. The purpose of this qualification operational test and evaluation (QOT&E) was to evaluate the ability of the F-16 20mm ALS to upload/download A-7D aircraft. The scope and specific objectives of this project were as follows:

a. Scope.

(1) The test was conducted from 15 through 25 September 1981. ANG A-7D aircraft, maintenance personnel, and facilities of the 121 TFW, Richenbacker ANGB, Ohio, were used. Testing included uploading/downloading of 20mm ammunition on A-7D aircraft during normal day-to-day operations and during simulated combat conditions. A portion of the test was conducted with load crews wearing chemical warfare defense ensembles (CWDE). Additionally, the modified replenisher was evaluated as to its ability to replenish the loader. Two production ALSs were used for the test. Only a limited operational suitability assessment was conducted because of the following factors:

- (a) Time available for the test was limited.
- (b) Test items were contractor maintained.
- (c) Technical data were supplied by the contractor.
- (d) No cold weather testing was accomplished.
- (e) Modified replenisher was operated by contractor personnel.

b. Specific Objectives

(1) Operational Effectiveness

(a) Objective 1. - To assess the capability of the F-16 ALS to upload/download ammunition into/from the A-7D aircraft;

(b) Objective 2. - To assess the interoperability of the ALS with both the A-7D gun system and the modified replenisher, A-7D

(c) Objective 3. To assess the capability of the modified replenisher to replenish the loader.

(2) Operational Suitability. Specific suitability objectives were not evaluated during this test. On site observations of some suitability areas (equipment failures, technical data, human factors, and chemical defense) were performed.

3. METHOD OF ACCOMPLISHMENT.

a. OT&E Environment. The ALS was tested in a tactical training environment using 121 TFW support equipment and military operations and munitions personnel. The ALS was operated by 121 TFW munitions personnel and maintained by General Electric personnel.

b. Method of Test and Evaluation.

(1) Initial test activity consisted of equipment setup at the 121 TFW munitions maintenance facility by General Electric personnel. Equipment setup was followed by load crew training, equipment safety certification, and modifying eight A-7D aircraft gun systems. The modification consisted of removing the existing loader-gun interface units and installing ALS loader-gun interface adapters. The General Electric technician and program engineer conducted all load crew training.

(2) Personnel participating in the test were briefed by test team personnel prior to each load/replenishing operation. Such topics as load/replenishing requirements, number of ammunition rounds required, timing procedures, and data collection procedures were covered.

(3) The loader was positioned adjacent to the aircraft prior to all load starts. The test team observed all facets of the loading operations and recorded the overall time and comments in the project manager's logbook. Timing for ammunition loading started after the load crew completed their safety briefing and ended when the load crew removed their tools and equipment. Timing for simulated combat turns started with the second wheel chock and ended with pilot acceptance of the aircraft.

(4) In the munitions storage area, a munition systems maintenance crew replenished the loader using the existing replenisher and a General Electric crew replenished the loader using the modified replenisher. General Electric personnel replenished the loader with the modified replenisher because it was an engineering prototype. Test team personnel

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observed the replenishing operations. All required 20mm ammunition and tools were at the work site prior to starting the operation. The test team timed each operation and recorded the times in the project manager's logbook. Timing began at the end of the crew safety briefing and ended when the loader was fully replenished and disconnected from the replenisher.

(5) The technical data used with the existing replenisher were taken from T.O. 35D30-4-11-1. Contractor supplied technical data was used for the modified replenisher.

(6) All work stoppages were documented in the project manager's logbook and included 1) reason for stoppage, 2) length of stop time, and 3) corrective action. At the end of the replenishing operations, the munitions crews were debriefed by test team personnel. After the debriefing, munitions personnel were required to complete questionnaires.

(7) Load crew questionnaires and observations, the munitions maintenance questionnaires, and the project manager's logbook were reviewed and times extracted. Mean time to load and replenish were computed and statistically compared at the 0.1 level of significance with the current systems.

#### 4. RESULTS AND DISCUSSION.

##### a. Operational Effectiveness.

(1) Capability of the ALS to upload/download ammunition into/from A-7D aircraft (Objective 1, paragraph 2b(1)(a)).

(a) Mean time to load the A-7D gun system was the measure for this objective. The associated criterion was that mean time to load the A-7D gun system must be less than or equal to the current system.

(b) After initial load crew training, ammunition loading was in conjunction with the day-to-day flying schedule of the 121 TFW. A total of 19 aircraft loading operations were completed. Two loads were accomplished during simulated combat turn conditions. Four aircraft loads were conducted with load crew personnel wearing CWDE. Approximately 30,000 rounds of live ammunition were processed using the ALS, and only one minor mechanical failure was encountered during the test.

(c) The mean time to load the A-7D gun system using the F-16 20mm loader is 13.33 minutes. Mean time to load with the current A-7D loading system is 13.50 minutes. A significance test conducted at the 0.1 level showed no significant differences between the two systems. Therefore, the new system has at least as good a capability to upload/download the A-7D aircraft.

(2) Interoperability of the F-16 20mm loader with both the A-7D gun system and the modified replenisher (Objective 2, paragraph 2b(1)(b)).

(a) Quality of the interface of the loader with both the A-7D gun system and the modified replenisher was the measure for this objective. The criterion was that no mechanical interface anomalies exist which degrade proper operation of the loader or replenisher.

(b) Test team personnel observed all facets of the loading operations with particular emphasis on mechanical interface of the loader with the aircraft gun system. No mechanical interface anomalies were observed between the loader and A-7D gun system or modified replenisher.

(3) Capability of the modified replenisher to replenish the loader (Objective 3, paragraph 2b(1)(c)).

(a) Mean time to replenish the loader was the measure for this objective. The associated criterion was that the mean time of the modified replenisher will be less than the existing replenisher.

(b) A total of 12 replenishing operations were completed, 6 using the existing replenisher, and 6 replenishing operations with the modified replenisher. One replenishing operation was conducted with munitions personnel wearing CWDE.

(c) The mean time to replenish 1,000 rounds using the existing F-16 replenisher is 22.55 minutes. Mean time to replenish 1,000 rounds with the modified replenisher is 7.64 minutes. A significance test conducted at the 0.1 level showed that the modified replenisher was a significant improvement over the existing F-16 system.

(d) The mean time to replenish 1,000 rounds on the existing A-7D loading system is 47 minutes.

b. Operational Suitability. Although there were no specific suitability objectives for this test, some suitability issues were subjectively assessed through on site observations by test team maintenance/loading specialists.

(1) Equipment Failures/Maintenance Problems.

(a) During aircraft loading operations, the air gun used to drive the aircraft gun system tended to ice over and freeze up when using the 3,000 psi air bottle on the loader trailer. This problem was corrected by using an antifreeze lubrication oil in the air guns.

(b) During one replenishing operation, the flexible drive shaft on the loader disconnected from the loader drive mechanism causing the system to stop. Contractor personnel determined that the outer case of the flexible drive was not manufactured to specifications. The outer case was removed and replaced with a shorter case, and the system operated without further failure.

(2) Adequacy of Technical Data.

The test team observed the load crews as they used the technical data to perform their operations. No discrepancies were discovered. Overall, the technical data were adequate.

(3) Human Factors.

During manual (hand cranking) operation of the production replenisher, the location and angle at which the replenisher must be cranked is cramped with the loader connected. If the drive connection was turned 90° to the side of the replenisher, hand cranking would be much easier. The fatigue factor could be drastically reduced by the installation of a two-to-one gear reduction adapter between the handle and drive mechanism.

(4) Chemical Defense.

Four aircraft loads and one replenishing operation were conducted with munitions personnel wearing CWDE. No problems were encountered during any of the operations. The fatigue factor in CWDE is reduced while operating the ALS as opposed to the current A-7D loading system, because fewer tasks are required during the F-16 ALS operation.

c. Deficiencies. The only two identified deficiencies (paragraphs 4b(1)(a) and (b)) were on the spot corrections and did not require AFTO Form 240 submissions.

d. Supplemental Findings.

(1) Low proficiency in the use of the ALS might have degraded the mean times for the ALS. As crew proficiency increased, time savings over the current loading system could be substantially increased.

(2) The A-7D gun system can be loaded by hand cranking when using the F-16 ALS.

(3) The size of the loader drum (1,615 rounds) is a limiting factor for the ALS when loading multiple A-7D aircraft. The contractor has designed a larger (2,100 rounds) drum that would greatly enhance the utility of the ALS. The current A-7D loader capacity is 4,000 rounds, which is four full gun loads. An additional 3,000 psi air bottle would be required to drive the larger drum.

(4) The potential foreign object damage problem is virtually eliminated with the ALS because it is a closed loop, linkless ammunition system.

(5) During replenishing operations, if there is an empty space between rounds in the loader chute, there is no provision to insert a missing round.

(6) No special tools were required to operate the ALS.

5. CONCLUSIONS.

a. The capability of the F-16 ALS to upload/download ammunition into/from the A-7D aircraft is operationally acceptable (paragraph 2b(1)(a)).

b. The interoperability of the ALS with both the A-7D gun system and the modified replenisher is operationally acceptable (paragraph 2b(1)(b)).

c. The capability of the modified replenisher to replenish the loader is operationally acceptable and is a vast improvement over the current A-7D ammunition loading system (paragraph 2b(1)(c)).

d. The capacity of the loader drum is not optimized for A-7D aircraft (paragraph 4d(3)).

e. Operational suitability of the modified replenisher was not evaluated (paragraph 2b(2)).

f. There is no provision to insert missed rounds in the loader (paragraph 4d(5)).

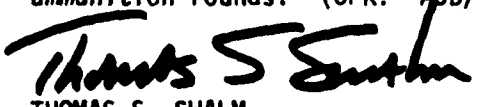
6. RECOMMENDATIONS. It is recommended that:

a. The F-16 20mm ALS be evaluated as to its ability to upload/download ammunition into/from F-15 and F-4E aircraft. (OPR: HQ TAC; Suspense: 1 April 1982.)

b. The operational suitability of the modified replenisher be evaluated in a field environment. (OPR: HQ TAC/LG; Suspense: 1 April 1982.)

c. ECP ALS-05606-0010 (increased capacity of loader to 2,100 rounds) be evaluated. (OPR: ASD/YPEC; Suspense: 1 February 1982.)

d. A gate be provided in the loader fixed-chute to insert individual ammunition rounds. (OPR: ASD/YPEC; Suspense: 1 February 1982.)

  
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